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masses from same sides of the pickup tines to adjust the pickup mode frequency of the tuning fork.

Concluded

REMARKS

The rejection of Claims 4 - 10 and 14 - 18 under 35 U.S.C. §112 as containing new matter is not understood.

With regard to Claim 4, the Examiner has stated that the specification as originally filed does not provide support for the use of the balancing masses currently or simultaneously while maintaining a balance in mass between the tines. That is ridiculous!

Initially, the words "currently" and "simultaneously" are not found in Claim 4, and the Examiner is apparently trying to read something into the claim which is not there. What the claim calls for is using balancing masses on the front surface of one tine and the rear surface of the other tine to eliminate quadrature displacement in the tines while maintaining a balance in mass between the tines. That is precisely what is disclosed throughout the specification, and it is shocking to applicant that the Examiner would suggest otherwise. Support for the claim language is found, for example, in the following portions of the specification [emphasis added]:

> This invention pertains generally to tuning forks for use in rate sensors and, more particularly, to a tuning fork and method in which mass balance is maintained when quadrature error is reduced. [Page 1, lines 1 - 3].
>
> Another object of the invention is to provide a tuning fork and method of the above character in which quadrature error is reduced without disturbing tine mass symmetry. [Page 3, lines 12 - 14].
>
> These and other objects are achieved in accordance with the invention by providing a tuning fork and method in which a pair of elongated tines having front and rear surfaces are disposed symmetrically about an axis, and balancing masses on the front surface of one tine and on the rear surface of the other tine are trimmed to reduce quadrature error and also to maintain mass balance between the tines. [Page 2, lines 15 - 20].
>
> To reduce quadrature error without producing an imbalance of mass between the tines, substantially equal amounts of mass are removed from opposite surfaces of the two tines. Thus, for example, removing a portion of mass element 26 from the upper surface of tine 11 will produce a reduction in

> quadrature signal. It will also produce an imbalance in mass between the tines. However, if a similar portion of mass element 29 is removed from the lower side of tine 12, there will be a further reduction in the quadrature signal, but the mass balance of the two tines will be preserved. This situation is illustrated in Figure 3, with the trimmed mass elements being identified by reference numerals 26a and 29a. [Page 4, lines 19 - 28].
>
> Instead of depositing masses on the tines and then removing portions of them to reduce quadrature signal, the same result can be obtained by the use of applied masses. In this case, masses are applied to opposite surfaces of the two tines to reduce quadrature error, and although the mass of the tines is increasing rather than decreasing, the symmetry of mass between the two tines is maintained. [Page 5, lines 21 - 26].

Similar support is also found in the claims as originally filed, *e.g.* Claims 1, 3, 4, 7 and 11.

From the Examiner's comment that the specification does not provide support for the use of the balancing masses currently or substantially while maintaining a balance in mass between the tines, it appears that the Examiner may be misinterpreting the term "while". In view of that possibility, the term "while" is being deleted from Claim 4, and the claim now calls for the use of balancing masses to eliminate quadrature displacement in the tines and to maintain a balance in mass. That terminology is fully supported by the specification and claims as originally filed.

The amendment to Claim 4 should also overcome the Examiner's concern about Claims 5 and 6 which depend from Claim 4. Moreover, contrary to the Examiner's statement, neither of those claims has ever required that the mass elements be added to both tines simultaneously.

Claims 7, 14 and 16 are being amended in a similar manner, and that should eliminate the new matter issue in them and in the claims which depend from them.

Claims 4 - 10 and 12 - 18 have also been rejected under 35 U.S.C. §112 for failure to particularly point out and distinctly claim the invention. Reconsideration and withdrawal of that rejection is also requested.

With regard to Claim 4, this rejection also appears to stem from the use of the term "while", and the elimination of that term should overcome this rejection, too. Once

again, however, applicant would point out that there is not and never was any "same time" requirement in Claim 4.

Amendments are also being made to the other claims which should eliminate the issues noted by the Examiner. However, to the extent that the rejection is based upon the lack of antecedent basis for the term "step" or "steps" in Claims 12, 13, 15, 17 and 18 is not understood. This is not a situation in which the dependent claims are referring back to steps in the parent claims. They are adding additional steps for which there is no antecedent.

The Examiner's objection to the term "if necessary" in Claims 14 and 16 also appears to be based upon a misunderstanding of the claims on the part of the Examiner and/or an erroneous notion that the presence of the term "if" always makes a claim indefinite or ambiguous. The language in question in both claims is "trimming the balancing masses if necessary to provide a balance in mass between the two tines". That simply and clearly says that the balancing masses are trimmed if it is necessary to do so in order to provide a balance in mass between the tines. If the masses of the tines are already balanced, then it is not necessary to trim the masses. Granted, this is a conditional limitation in that the trimming of the masses is conditioned upon the need to do so, but that does not make the claim indefinite. There is no ambiguity or doubt as to what is being claimed.

With this explanation and the amendments which are being made, applicant trusts that the rejections of the claims under 35 U.S.C. § 112 will be withdrawn and that the claims which have been rejected on formal grounds only (Claims 5 - 10 and 14 - 18) will be allowed. Claims 5 and 6 are being written in independent form in order to further place them in condition for allowance.

Claim 4 has been rejected under 35 U.S.C. §102 as being anticipated by the newly cited Kawamura reference (U.S. 3,760,482). Reconsideration and withdrawal of that rejection is requested.

Kawamura is concerned with adjusting the frequency of a tuning fork and having the frequency of the two tines coincide. It does so by cutting away portions of the base portion ("root") between the two tines, not by adding masses to or removing masses from the surfaces of the tines. Asymmetric placement of the cut in the base alters the relative frequencies of the two tines by changing the relative spring constants of the tines (Col. 2, lines 41 et seq.), while symmetrical removal of material from the base adjusts the overall frequency of the fork without affecting the relative frequencies of the tines.

Claim 4 distinguishes over Kawamura in calling for the use of balancing masses on the front surface of one tine and the rear surface of the other tine to eliminate quadrature displacement in the tines and maintain a balance in mass between the tines. Kawamura does even mention quadrature displacement, mass balancing, or the use of balancing masses on the surfaces of tines, and the Examiner is mistaken in suggesting otherwise. Without those elements, Kawamura does not anticipate, and the rejection is clearly erroneous.

Claims 11 - 13 have been rejected under 35 U.S.C. §103 as being unpatentable over the two Macy et al. (U.S. 4,930,351) in view of Macy (U.S. 5,542,249). Reconsideration and withdrawal of this rejection is once again requested.

Claims 11 - 13 distinguish over the references in calling for the steps of applying balancing masses to the front and rear surfaces of the drive tines, and trimming the balancing masses on opposite sides of the drive tines to eliminate quadrature displacement without affecting mass balance between the drive tines. Contrary to the Examiner's suggestion, the electrodes on the surfaces of the tines in the references are not balancing masses, and they are not trimmed to eliminate quadrature displacement without affecting mass balance between the tines.

As pointed out in response to the previous Office Action, while applicant's invention and Macy may both be concerned with the elimination of quadrature error, they do so in different ways. In Macy, the pickup electrodes are trimmed to produce

an electrical null in the quadrature signal, whereas in applicant's invention balancing masses are utilized to eliminate quadrature vibration and to maintain a balance in mass between the tines. One is an electrical technique; the other is mechanical.

The electrical balancing technique of Macy is quite different than applicant's invention. In the single-ended tuning fork of Macy, piezoelectrically induced drive charge is present on the pickup electrodes. If this charge is not perfectly symmetrical in its distribution on the various pickup electrodes, there will be a net quadrature signal in the output since the drive charge signal is in quadrature phase relation to the rotation-induced Coriolis signal. By trimming away electrode area, an intentional change in the electrode symmetry is created to produce an electrical nulling of the quadrature signal.

Contrary to the Examiner's suggestion, the pickup electrodes in Macy are not balancing masses. Their function is to provide electrically conductive regions for sensing piezoelectrically induced charge, and their mass is insignificant. Such electrodes are typically only 100 - 200 nm thick, whereas balancing masses as employed in applicant's invention may be as thick as 10,000 nm and a relatively heavy metal such as gold.

The location of the pickup electrodes relatively close to the base of the tines in Macy also makes their mass less significant since they are farther away from the free ends of the tines which move with significantly more velocity than the areas near the base.

In contrast, in applicant's invention, there is a true mechanical balancing in which the mechanical properties of the tines are altered such that the actual quadrature displacement in the pickup mode of vibration is reduced or eliminated.

Claim 11 distinguishes over Macy and Macy et al. in calling for the steps of applying balancing masses to the front and rear surfaces of the drive tines, and trimming the balancing masses on opposite sides of the drive tines to eliminate quadrature displacement without affecting mass balance between the drive tines.

Claims 12 and 13 depend from Claim 11 and are directed to patentable subject matter for the same reasons as their parent claim.

Claim 12 further distinguishes in calling for the step of trimming the masses on same sides of the drive tines to adjust the drive mode frequency of the tuning fork.

Claim 13 further distinguishes in calling for the steps of providing masses on the pickup tines, and trimming the masses on the pickup tines to adjust the pickup mode frequency of the tuning fork.

With this amendment, it is respectfully submitted that Claims 4 - 18 are all directed to patentable subject matter and that the application is in condition for allowance. Formal drawings will be submitted separately.

The Commissioner is authorized to charge any fees required in this matter, including extension fees, to Deposit Account 50-2319, Order No. A-68944/ESW.

Respectfully submitted,

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Edward S. Wright

EDWARD S. WRIGHT

4. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, and using balancing masses on the front surface of one tine and the rear surface of the other tine to eliminate quadrature displacement in the tines [while maintaining] <u>and maintain</u> a balance in mass between the tines.

5. <u>In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis,</u> [The method of Claim 4 wherein quadrature displacement is eliminated and balance is maintained by] applying mass elements to the tines, and removing portions of the mass elements from the front surface of one tine and from the rear surface of the other <u>to eliminate quadrature displacement in the tines and maintained a balance in mass between the tines</u>.

6. <u>In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, and</u> [The method of Claim 4 wherein quadrature displacement is eliminated and mass balance is maintained by] adding mass elements to the front surface of one tine and the rear surface of the other tine <u>to eliminate quadrature displacement in the tines and maintained a balance in mass between the tines</u>.

7. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines having free ends of increased lateral dimension with laterally offset balancing masses on opposite sides of the tines near the free ends, and adjusting the balancing masses on opposite sides of the two tines

to eliminate quadrature displacement in the tines [while maintaining] <u>and maintain</u> a balance in mass between the tines.

8. The method of Claim 7 wherein the balancing masses are adjusted by removing substantially equal amounts of [them] <u>the balancing masses</u> from the opposite sides of the two tines.

9. The method of Claim 7 wherein the tines are fabricated of a material which is transparent to a laser beam, and the balancing mass on one side of one of the tines is trimmed by passing the laser beam through the tine to the balancing mass.

10. The method of Claim 7 further including the step of removing substantially equal amounts of the balancing masses from same sides of the tines to adjust the drive mode frequency of the tuning fork.

11. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming an elongated pair of drive tines having front and rear surfaces, forming a pair of pickup tines having front and rear surfaces, applying balancing masses to the front and rear surfaces of the drive tines, and trimming the balancing masses on opposite sides of the drive tines to eliminate quadrature displacement without affecting mass balance between the drive tines.

12. The method of Claim 11 further including the step of trimming the masses on same sides of the drive tines to adjust the drive mode frequency of the tuning fork.

13. The method of Claim 11 further including the steps of providing masses on the pickup tines, and trimming the masses on the pickup tines to adjust the pickup mode frequency of the tuning fork.

14. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, applying balancing masses to the front and rear surfaces of the tines, trimming the balancing masses if necessary to provide a balance in mass between the two tines, and thereafter removing substantially equal amounts of the balancing masses from the front surface of one of the tines and from

the rear surface of the other to eliminate quadrature displacement in the tines [while maintaining] <u>and maintain</u> the balance in mass between [them] <u>tines</u>.

15. The method of Claim 14 together with the step of removing substantially equal amounts of the balancing masses from same sides of the two tines to adjust the drive mode frequency of the tuning fork.

16. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming elongated pairs of drive and pickup tines which have front and rear surfaces and extend in opposite directions from a central body, applying balancing masses to the front and rear surfaces of the drive tines, trimming the balancing masses if necessary to provide a balance in mass between the drive tines, and thereafter removing substantially equal amounts of the balancing masses from the front surface of one of the drive tines and from the rear surface of the other to eliminate quadrature displacement in the drive tines [while maintaining] <u>and maintain</u> the balance in mass between them.

17. The method of Claim 16 further including the step of removing substantially equal amounts of the balancing masses from same sides of the drive tines to adjust the drive mode frequency of the tuning fork.

18. The method of Claim 16 further including the steps of applying balancing masses to the pickup tines, and removing substantially equal amounts of the balancing masses from same sides of the pickup tines to adjust the pickup mode frequency of the tuning fork.